FACT SHEET SUSTAINABLE ALTERNATIVES TO KEROSENE
This fact sheet describes facts about sustainability with a focus on CO₂ emissions during flight*. This is based on data from before the coronavirus crisis (1 March 2020).

Aircraft are becoming increasingly fuel-efficient, so why are CO₂ emissions increasing?

1. With a consumption of just over three litres per hundred passenger kilometres¹, a modern medium to long-haul passenger aircraft (such as the A330neo-900, with an occupancy rate of 80%) is more fuel-efficient² than a standard petrol car with two passengers.
2. Thanks to incremental, step-by-step developments and gradual fleet replacement, flying is becoming some 1.5% more fuel efficient (per passenger kilometre) each year³⁴. The increased occupancy rate - from 70% in 2000 to over 80% in 2019⁵ - also contributes to this.
3. However, between 1995 and 2015, the global number of kilometres travelled by air increased by an average of 5.4%, as a result of which CO₂ emissions are still rising every year⁶.

What about the CO₂ emissions?

4. CO₂ is the largest individual contributor to the climate impact of aviation worldwide. Climate effects other than those caused by CO₂ - such as NOx (nitrogen oxides), soot particles and water vapour (resulting in condensation trails and cirrus clouds) - are not explicitly included in this fact sheet. According to the most recent estimates, the climate impact of aviation is therefore more than twice as high⁷.
5. 75% of the flights from Schiphol are short flights (up to 2000 km), and account for 16% of the CO₂. The remaining 25% are long-haul flights that emit 84% of the CO₂.
6. Emissions from fossil kerosene at Dutch international airports contributed over 6% of the total CO₂ emissions for the Netherlands in 2018⁸⁹. Globally, that contribution made by aviation is between 2 and 3%¹⁰¹¹."}

What is involved in flying on hydrogen?

11. A major technical challenge is the storage of hydrogen in the aircraft. This can be done in liquid form at a very low temperature (-253 °C)³¹, or in gaseous form under very high pressure (700 bar¹²). A robust tank or insulation carries extra weight.
12. The advantage of hydrogen as an energy carrier is that it contains three times more energy per kilogram than kerosene¹³. In liquid form, hydrogen occupies up to four times more volume per kilogram, and in gaseous form under high pressure up to 10 times more volume¹⁴, which is detrimental.
13. Hydrogen can be burned directly in a gas turbine for propulsion or converted in a fuel cell into electricity to drive an electric motor (in both cases, 40-45% energy efficiency for a large aircraft¹⁵). Depending on its configuration, a hydrogen-powered aircraft can travel up to several thousand kilometres.
14. Liquefied natural gas (LNG) can serve as a prelude to hydrogen-powered aviation¹⁶. This is mainly due to the high availability, the already existing infrastructure and the relatively favourable energy density²⁸. It is also the only energy carrier that comes close to kerosene in terms of price²⁹.

What can we do with ‘Sustainable Aviation Fuels’ (SAF)?

15. With the current aircraft concepts/configurations, long-haul flights are only feasible with hydrocarbon-based energy carriers such as conventional, biokerosene or synthetic kerosene³⁰.
16. Biokerosene is obtained from the refining of biomass³¹. Sustainable synthetic kerosene is synthesised from H₂ (hydrogen) and captured CO₂ using (green) electricity³²³³. Current aircraft can use SAF in a blending ratio of up to 50% with conventional kerosene without making modifications and within current regulations. Higher blending percentages may require engine and fuel system modifications³⁴. According to IATA, less than 1% of the kerosene uplift worldwide is SAF³⁵.
17. The raw materials and production processes must meet strict sustainability criteria³⁶. Over its life cycle, the CO₂ balance of SAF can be considerably lower than that of fossil kerosene (from 85% to as much as 100% CO₂ reduction for biokerosene³⁶ and synthetic kerosene³⁷).
18. The production of one kilogram of synthetic kerosene (energy content: 12 kWh) requires three to four times more energy in electricity³⁸³⁹. In 2019, the aviation sector consumed approximately four million tonnes of kerosene for flights out of the Netherlands⁴⁰⁴¹. Producing this amount of synthetic kerosene would require almost ten times the total production of green electricity in the Netherlands (21.8 billion kWh in 2019)⁴².
19. Biokerosene is currently three to four times more expensive than fossil kerosene. Synthetic kerosene is five to six times more expensive. In addition, the scale-up of production and availability of raw materials are currently limiting factors for the use of SAF³⁸⁴⁰⁴³-⁴⁵.

Is electric flying a solution?

10. The gain to be obtained at the airports themselves - before take-off and after landing - for example by electric taxiing, is not included.
Sources for the FACT SHEET SUSTAINABLE ALTERNATIVES TO KEROSENE

7. Long-Term Traffic Forecasts. ICAO; 2018 Apr pp. 1-17.
10. CBS. Motor fuels; sales in petajoules, weight and volume. opendata. cbs.nl.